



1896

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# THE KRÖMSKÖP

## AND ITS SYSTEM OF

### COLOUR PHOTOGRAPHY

**I**T is more than half a century since Daguerre first fixed the camera image on the silver plate which, under the name of the Daguerreotype, astonished and interested the world.

The success of this great discovery was followed by a universal expression of desire for a method of photography in the natural colours. Time after time it has been asserted that the problem was solved, but one disappointment followed another until, as a German writer recently said, "photography in the natural colours seemed, only a short time ago, as far away as the stars in the skies."

From time to time, and by various methods, photographs in colour have been obtained by comparatively simple, direct methods; but the colours have very seldom, if ever, been like those of the objects photographed, unless we must except some examples by Professor Lippmann's interferential method. A few striking and even beautiful results

were obtained by that method, probably out of thousands of exposures, in 1893. But even Professor Lippmann's photographs showed colour only when viewed at a certain angle, and the results were so very uncertain that we no longer hear of further experiments in the same direction.

Already, over a quarter of a century ago, the problem had been attacked from a different direction, a method having been suggested which involved the production of a colour record, consisting of three photographs to represent the three primary colours, and the combination of these images by optical superposition. This idea, although it involved theories and complications that were very distasteful to the seekers after a direct method of colour photography, is to-day represented by the first successful method of reproducing the natural colours by photography,—the Krömskōp system.

The first suggestion was made by Professor James Clerk-Maxwell, in a lecture delivered at the Royal Institution, London, May 17th, 1861; from which the following quotation is taken:—

“ The speaker assuming red, green, and blue, as primary colours, then exhibited them on a screen by means of three magic lanterns, before which were three glass troughs containing respectively, sulphocyanide of iron, chloride of copper, and ammoniated copper.

“ A triangle was thus illuminated, so that the pure colours appeared at its angles, while the rest of the triangle contained the various mixtures of the colours, as in Young's triangle of colour.



"The graduated intensity of the primary colours in different parts of the spectrum was exhibited by the coloured images, which when superposed on the screen, gave an artificial representation of the spectrum.

"Three photographs of a coloured ribbon, taken through the three coloured solutions respectively, were introduced into the lantern, giving images representing the red, the green, and the blue parts separately, as they would be seen by Young's three sets of nerves separately. When these were superposed, a coloured image was seen, which, if the red and green images had been as fully photographed as the blue, would have been a truly-coloured image of the ribbon. By finding photographic materials more sensitive to the less refrangible rays, the representation of the colours of objects might be greatly improved."

Thirty-five years have passed away since the words quoted were delivered. In the course of the quarter century following the lecture, means for producing colour-sensitive photographic plates were discovered, and such plates were employed in the manner suggested by Maxwell, although his lecture appears to have been entirely forgotten. The idea, which was for some years accredited to Frenchmen, Louis Ducos du Hauron and Charles Cros (1868), was afterwards traced back to Henry Collen, an Englishman, and again to Baron Ransonnet, an Austrian, whose suggestions appeared in 1865; and only attributed to Maxwell thirty-three years after he delivered his lecture upon the subject at the Royal Institution.

Collen and Ransonnet extended Maxwell's idea by suggesting the production of permanent composite colour prints from the negatives of the colour record,

and Louis Ducos du Hauron further suggested a means of optically superposing the images by a device containing transparent mirrors, which, although clumsy and unsatisfactory, embodied the first hint of the Krömskōp. He also proposed a method of realising a similar result with a single photograph, by making it a kind of mosaic of the three elements of the Maxwell colour record, and viewing it through a mosaic colour-screen,—a method since revived by Dr. Joly.

But there was a vital defect in all the suggestions which had been recorded up to 1888, when Mr. Ives pointed out that, although the three pure colours, red, green, and blue-violet, must be used for the lantern projections (because they are the only ones that will mix to reproduce all other hues), the photographs themselves must be made through colour filters permitting not only the primary colours to act upon the sensitive plate, but also all other hues into which they must enter in the synthesis. For example, the spectrum yellow, which is reproduced to the eye by mixing red and green spectrum rays, must act as well as the red in the photograph to be projected by red light, and as well as the green in the photograph to be projected by green light, and the relative action must be quantitatively worked out. It follows that the same colour screens cannot be employed for both the photographic process and the synthesis by projection, as was done by Maxwell, Du Hauron, and others.



The spectrum colours change as the wave-length of the light varies ; but colour does not depend upon wave-length only, and this is a fact of the greatest importance in its bearing upon the subject of colour reproduction by photography.

The Young-Helmholtz theory of colour vision explains this fact by assuming that there are three fundamental colour sensations—a red, a green, and a blue-violet—which may possibly be due to three kinds of nerves in the eye, and that all other colours are compound sensations. Clerk-Maxwell assumed that the spectrum red, green, and blue-violet rays excited almost exclusively the respective fundamental colour-sensations, and that all other visible spectrum rays excited simultaneously two fundamental sensations. By means of his now celebrated “colour-box,” he made measurements of spectrum colour mixtures, and plotted curves showing in what proportions his so-called fundamentals combine to reproduce the other hues of the spectrum.

Although Maxwell’s conclusions with respect to the fundamental sensations have been proved not to be strictly correct, it is nevertheless true that all the colours of the spectrum, and therefore all the colours in Nature, are substantially “equivalent to mixtures of three colours of the spectrum itself.”

The Krömsköp system of colour photography is based upon, and is substantially an application of

these facts. Three photographs of the object are made, because three colours are required to reproduce all others ; and each photograph is made by the joint action, in due proportion, of the respective fundamental colour, and all other hues into which it must enter in the reproduction ; but each photograph is afterwards seen by light of the fundamental colour only, and the three are blended into one composite image.

A camera, which is probably no more complicated than a "kodak," makes the negative images which constitute the colour record on a single sensitive plate, at one exposure ; and a contact positive from this negative, when cut in three and mounted on a folding cardboard frame, can in a moment be dropped into another optical instrument, the Krömskōp, which, as well as the camera, is stereoscopic, and is even then not much larger than some of the ordinary hand stereoscopes. The colour record, or "kromogram," when viewed in this instrument, realises a reproduction which is so satisfying to the eye that the uninitiated imagine that it is the object itself at which they are looking. It is far more realistic than any ideal colour photograph on a flat surface could be, because the image is free from surface reflections and distracting surroundings, and is in perfect stereoscopic relief.

Even if perfect colour-photographs could be made by a direct process, the result would, in many



instances be comparatively unsatisfactory, unless the photographs were made stereoscopic, and seen in a stereoscope, which would involve just as many operations as are necessary to obtain the same result by the Krömskōp system. And the Krömskōp colour record possesses the important advantage that, unlike most coloured pictures, it is absolutely permanent, showing exactly the same colours to-day and fifty or a hundred years hence.

It is true that this is not exactly the kind of colour photography that the world has been looking for. Although in practice, given the special apparatus to work with, the operation of the process is beyond criticism for ease and simplicity, and the result perfectly satisfying to the eye, it is not what many people have desired, because it does not produce fixed coloured images which can be framed and hung upon the wall, or in a window, or inserted in a book. Fixed colour prints can be made from the Krömskōp negatives, but only by so greatly complicating the procedure as to make it comparatively impracticable.

Who can doubt that the production of a perfectly life-like representation, by a simple and easy process, even though requiring the use of a special viewing instrument to complete it, is of vastly greater importance than the production of flat colour-prints by complicated and yet comparatively imperfect methods?

The form of the Krōmskōp suggests steps of stairs. The red image, lying horizontally on the top step, is seen by reflection from the first surface of a transparent mirror of cyan-blue glass, which stands underneath it and in front of the eye, inclined at an angle of  $45^{\circ}$ . The blue-violet image lies upon the second step and is seen (through the cyan-blue glass above-mentioned) by reflection from the first surface of a transparent mirror of yellow glass, which is also inclined at an angle of  $45^{\circ}$  beneath the image. The green image, standing upright against the lower step, is viewed directly through the cyan-blue and yellow transparent mirrors, both of which transmit the green light. By this means the three images are so blended as to appear as one to the eye. The use of coloured glass reflectors avoids double reflections, and consequent doubling of outlines, it being only necessary to use glasses the substance of which absorbs light of the colour which they are intended to reflect from the first surface.

